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APPLICATION OF BURNT OIL PALM SHELLS AS GRANULAR MEDIA FILTRATION FOR PHYSICAL AND BIOLOGICAL CONTAMINANTS REMOVAL IN THE WATER TREATMENT PROCESS

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledge as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

This study was conducted to discover a new filtering media, specifically for pathogenic microorganism removal for the water treatment industry to produce safe drinking water. Granular bed filtration was used in this study as a healthy, simple and economical method to prevent the penetration of bacterial contamination. Alternative filter media from local source namely the burnt oil palm shell (BOPS) was also introduced. In order to determine the BOPS performance, the experimental programme and research approach used in this study were the design and construction of filtration unit, preparation of filter media, determination distribution size, morphology, porosity and specific gravity of filter media and also physical and biological analysis of filtrate water. In addition, total coliform and *Escherichia coli* tests of filtrate water in single-, dual- and tri-media filter were also investigated. Physical properties of BOPS were found to be equivalent or superior to those commercialized available granular filter media with ball-pan hardness of 97.30%. Granular media filter with mix media classes (which is a dual-media filtration) is also found to be a reliable surrogate for physical removal and biological barrier during filtration studies. Dual-media filtration BOPS/sand ES 1.0/0.5 mm is operating optimum condition of removing 80.77% of turbidity, 76.23% of suspended solid, 59.45% of colour and for bacteriological 0.63 log and 0.46 log of removal for total coliform and *Escherichia coli*. There was statistically significance difference between types of media filter to the removal of physical variable at 0.05 level as determined by one-way anova for the turbidity % removal ($p = 0.000$), suspended solid % removal ($p = 0.000$) and colour % removal ($p = 0.000$). Under one-factor analysis, there was a statistically significant difference for dual-media filtration for *Escherichia coli* removal ($p = 0.001$), but not significant for single- and tri-media filter. Both Tukey HSD and Scheffe post hoc analysis revealed that BOPS/Sand: 1.0/0.5mm significantly higher log of removal by compared to commercial filter media anthracite/sand. The study also identified that energy losses were correspondingly to the porosity and shape factor value of media filter. Moreover, lower diameter grain size resulted in higher energy losses. The BOPS was identified as a potential filter media that can help in reducing the cost of water treatment and enhancing environmental sustainability. Thus, the final result of this study has found that BOPS can be used as a new biodegradable medium filter in water treatment process specifically for the removal of pathogenic microorganism.

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CHAPTER ONE
INTRODUCTION

1.1 GENERAL

Water is the most essential requirements in our daily life. It is now universally agreed that by providing the community with safe water, the plague of water-borne diseases can be prevented. Thus, the primary objective of the water supply scheme is to provide safe water supply for the community. However, with the increasing global concern on the environment, the utilization of agricultural waste transformed into wealth material for value-added products such as coconut shells, cocoa shells, banana peels, bamboo and oil palm kernel shell should be given priority. Using agricultural waste as filtering media in water and wastewater treatment has been a more popular method compared to anthracite, sand or granular activated carbon. In fact, during the last decades, the literature and knowledge on natural filter media in water treatment industry has increased substantially (Jusoh et al., 2009).

Abundantly available in Malaysia, easy to maintain and having a good economical value serve as the reason for the discovery of new filtering media in water treatment industry (Allwar et al., 2008; Aziz and Mamat, 2011; Jusoh et al., 2009). Therefore, new agricultural waste product such as palm oil shell is introduced as an alternative of filtering media material. The amount of palm oil shell waste produced has increased tremendously due to the advancement of palm oil industries in Malaysia as it was reported that the total oil palm kernel production in January-March 2013 is about 1,090,319 tonnes (MPOB, 2013). Therefore, the use of palm oil shell as a filtering medium could reduce dependency on other raw materials in the water treatment industry (Aziz and Mamat, 2011; Budari et al., 2013; Jusoh et al., 1995).

1.2 SIGNIFICANCE OF THE STUDY

In order to discover a new filtering media specifically for microorganism removal, the success of this research will be beneficial for the water treatment industry in the production of safe drinking water through filtration optimization or environmental engineering application. Therefore, this research is expected to